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ABSTRACT

This Information Bulletin reviews nine books or kits providing useful activities for using calculators in grades 2-9, plus several articles providing constructive suggestions. The materials were selected on the basis of five criteria: ease of integration within the present curriculum, power to sustain interest, degree of attention to essential skills, coherence and organization, and potential to increase the amount and level of mathematics learning. (MNS)

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Information Bulletin No. 12
January 1982

USING CALCULATORS: WHAT ARE THE BEST PUBLISHED MATERIALS? (grades 2-9)

Prepared by Walter Szetela

Calculators are everywhere -- except in schools.

- 75% of 9-year-olds have access to calculators outside the classroom
- 84% of teachers say that calculators should be used in the classroom

Yet -- only 35% of teachers actually use calculators in their classes.

Perhaps one of the reasons for this rather low level of use is lack of knowledge about good materials to use with calculators. Many thought a calculator-based curriculum would be in use by now. Instead, textbooks provide (at best) two- or three-page sections of calculator activities (usually for enrichment). But there exist numerous books, worksheet masters, and kits to supplement the textbook.

To help you in selecting appropriate materials, this bulletin provides reviews of "9 of the best." The criteria for selection of these materials were:

- ease of integration within the present curriculum
- power to sustain interest
- degree of attention to such essential skills as estimating, rounding off, and developing mental arithmetic skills
- coherence and organization of calculator activities
- potential to increase the amount and level of mathematics learning

So -- here's one person's opinion!

.....

EXPLORING WITH CALCULATORS

1. Calculator Explorations and Problems by Don Miller. (Cuisenaire Company of America, New Rochelle, New York, 1979. 103 pages, \$5.95.)

The introduction states that "this book is particularly suitable for grades 5-9, to supplement existing mathematics curriculum" and "to introduce new ideas and reinforce concepts." The general appear-

ance is bland, with no diagrams or cartoons, probably an asset: students are less likely to be distracted.

There are excellent pages for learning from patterns. Instructions are brief and clear. Estimation and mental arithmetic activities are excellent.

One concern may be an optimistic expectation of students' thinking ability required in the challenging activities. The "Exploring Algorithms" section is

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said "to provide a variety of ways in which exploration of the standard computational methods can lead to further insight. Careful analysis of procedure is made possible by placing the emphasis on the underlying ideas involved." The tasks are not easy, but achieving understanding does require the thinking we'd like to see more often in mathematics classes.

The pattern of presenting both calculator and mental arithmetic in coordination is a strong feature.

Comparing Estimates

Mentally estimate the largest (L) and the smallest (S) of the three numbers in each exercise. Write L and S above those you think are correct and then check with your calculator. Score 4 points if both of your estimates are correct. Score 1 point for one correct estimate.

1) 91×81	8100	79 $\times$ 99	☐
2) 41×31	19×49	1200	☐
3) 21×81	2400	19×89	☐
4) 29×87	49×49	2700	☐
5) 61×29	1500	29×48	☐
6) 30	9.7×3.8	4.9×7.1	☐
7) 4.1×8.2	6.9×6.9	50	☐
8) 6.2×4.9	32	8.9×3.9	☐
9) $4 \times 93 \times 25$	$5 \times 96 \times 20$	9400	☐
10) $1123 - 497$	$1231 - 497$	$1213 - 497$	☐
11) $865 + 435$	$867 + 453$	$867 + 534$	☐

My Score: _____

75 Estimation, Mental Computation, Ordering Numbers, Solving Problems, Comparing Answers. © Creative Publications, Inc. and Publishers. A Division of Creative Publications of America, Inc.

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Problems for "experts" are well-named. The section on exploring exponents and decimals is also superior. All answers are in the back pages. Exploration sections include Algorithms, Number Patterns, Short-cuts to Mental Computation, Equations and Problem Solving, Exponents and Decimals, and Estimation.

The text contains more wheat and less chaff than almost any other booklet I

reviewed. Teachers may find some students struggling, but there is also excellent potential for higher ability students.

2. Calculator Activities for the Classroom, Books 1 and 2 by George Immerzeel and Earl Ockenga. (Creative Publications, Palo Alto, California, 1977. 122 pages, \$7.25.)

My initial instincts were to omit these books from the recommended list, perhaps because they are "older" but also because I find the many cartoons distracting. As I inspected other calculator activity books, more and more it became clear that these two books contain a great many activities of worth for developing skills and concepts and ability to solve problems.

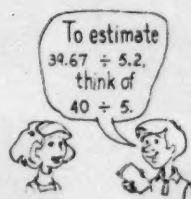
ESTIMATE, THEN CALCULATE

This game may be played by one or two players.

RULES

- Each player needs a copy of this sheet.
- A player enters the first number into the calculator, pushes $\div$, and enters the second number.
- Each player writes an estimate of the answer.
- A player pushes $=$, and each player writes the calculation rounded to the nearest thousandth.
- Each player compares his or her estimate with the calculation. The player whose estimate is closest to the calculation circles his or her estimate.
- The player who has the most circled estimates wins.

1) $24.35 - 4.1$	6) $41.85 - 7.12$
Estimate Calculation	Estimate Calculation
2) $135.6 - 9.85$	7) $12.64 - 3.13$
Estimate Calculation	Estimate Calculation
3) $2.4 - 62$	8) $5.4 - 9.1$
Estimate Calculation	Estimate Calculation
4) $14.103 - 7.1$	9) $14.103 - 0.71$
Estimate Calculation	Estimate Calculation
5) $8.1 - 0.9$	10) $1.032 - 4$
Estimate Calculation	Estimate Calculation



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The activities in content, form, and sequence appear attainable in the range

of grades 4-7, as the authors suggest. Book 1 includes operations with whole numbers and decimal and common fractions. Book 2 contains the same topics and also integers, percent, and measurement. Each book contains 17 pages on getting to know the calculator, which I find somewhat unnecessary, perhaps more so now that so many students own calculators and learn to use them easily. Many of the activities are game-oriented but not at the expense of worthy objectives.

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3. 2,4,6,8 Let's Start to Calculate
by Jessica Davidson. (Cuisenaire Company of America, New Rochelle, New York, 1976. 49 pages, \$4.95.)

This is another "older" calculator book with no visual appeal, but it bears up well under scrutiny with respect to developing skills and ideas.

(Multiplying by 10 - decimal) E-VI

Lazy man's arithmetic

What happens when you multiply a number by 10?

Jonathan says, "2 x 10 is 20 and 3 x 10 is 30 so all you have to do is put a zero to the right of the number which you are multiplying by 10." Is he right?

Begin by finding out how your calculator works when you want to multiply several numbers by the same number. Some calculators work one way, some another. Find out which kind of calculator yours is. You know it tells you that 4 x 10 is 40.

Try this way first by pressing these keys in succession:
10 x 2 = 20 x 4 =

Does it give you the answers 20, 80 when you press the equal sign?

If it doesn't, try the second way:
Press 2 x 10 = 20 x 4 =

Now check John's statement on the calculator:

17	x	10	=	170
1765	x	10	=	17650
118	x	10	=	1180
388	x	10	=	3880

But does John's idea always work?

What is 5 x 10 = ?
Is the answer 50?
Try it and see.

Both say, "Jonathan's rule works with whole numbers. If there's a decimal point, you just move it one place to the right when you multiply by 10." Does Beth's rule work?

Try these on the calculator:

.45	x	10	=	4.5
1.14	x	10	=	11.4
28.9	x	10	=	289
383	x	10	=	3830

Can you think of a way to use Beth's rule for all numbers whether there's a decimal point or not? (See page E-VI-3.)

"2, 4, 6, 8 Let's Start to Calculate" Cuisenaire Company of America, Inc. 17

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It contains sections on Jokes (harmless), Order, Multiplication and Division, Rounding and Estimating, Powers and Exponential Notation, Multiples and Primes, Signed Numbers, Absolute Values, and Challenges. Sections are identified by E for Easy and H for Hard. Only a few pages are expended on jokes, and they are designed mainly to develop skill in using calculators.

The pages are plain but the directions for activities are clear and well-sequenced. The amount of reading relative to computation seems heavy, but each activity pursues a worthwhile and attainable objective.

The book was designed "principally for use at the fifth to ninth grade level." While the sets of activities appear disjoint, each one can easily be integrated with topics from today's curriculum.

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PROBLEM SOLVING WITH CALCULATORS

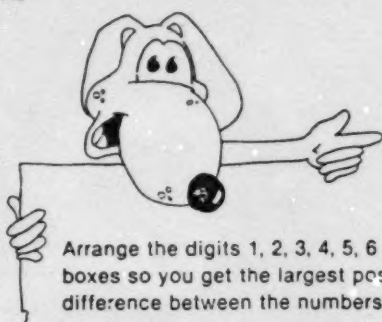
4. Problem Solving Using the Calculator -
Book 1 (Grade 5), Book 2 (Grade 7);
Problem Solving Using Calculator Codes -
Book 1 (Grade 6), Book 2 (Grade 8)
by Earl Ockenga et al. (Project Impact, Price Laboratory School, University of Northern Iowa, Cedar Falls, Iowa. \$20.00 each.)

Each of the above listings is an instructional module consisting of a problem-solving deck of 100 cards, a teacher's guide, and black-line masters for student booklets. The guide contains very clear and precise directions and suggestions for the use of the materials, two forms of a problem-solving test, and answers to all problems. The pupil pages include a record sheet as well as many additional problems so that students can record problems attempted and problems solved.

There are five levels of difficulty among the color-coded cards. In addition to the interesting and attractively constructed problems, one of the most valuable

features of these modules is the set of suggestions for solving problems by following the Polya four-step problem-solving plan. On the reverse side of every card, students are given either some information, questions, or hints which help them to understand the problem, devise a plan, work it out, and look back.

Y18



Arrange the digits 1, 2, 3, 4, 5, 6 in the boxes so you get the largest possible difference between the numbers.

Y18

GET TO KNOW THE PROBLEM You must put one number in each box. No number is used twice. "Difference" is the answer to a subtraction exercise.

CHOOSE WHAT TO DO Guess and check.

DO IT Keep guessing and checking. Look for the largest difference.

LOOK BACK Is the top number between 650 and 655? Arrange the digits to get the smallest possible difference.

Calculator 1

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Among hints for the Grade 5 module are leading questions, advice to estimate, questions about the answer being a number or object, questions about how many different answers are expected, instructions to guess, and directions to use a table. Similar hints are provided for the other three steps.

These modules are a valuable contribution, especially in light of the NCTM recommendations for mathematics teaching in the 1980s. The materials should serve as a model for teaching problem solving as a desired goal of mathematics instruction.

5. **The Calculator Workbox** by J. Norman Sharp. (Addison-Wesley (Canada) Ltd., Don Mills, Ontario, 1977.)

The teacher's guide states that these 80 problem cards designed for use in junior secondary schools "save time and frustration in solving problems, and as pedagogical devices deepen understanding of ideas in grades 7-8." The challenging problems are excellent for enrichment, but many problems are more generally suitable.

Every eighth card is a self-test based on the previous cards. Test answers appear in the teacher's guide.

MEASUREMENT 35

Area Measure with Circles

The relationship between the length of the radius r and the area A of a circle is given by the formula $A = \pi r^2$. Use $\pi = 3.1416$.

A A steel washer has a radius 2.72 cm and the radius of its hole is 1.54 cm. Find its area.

B A circle is inscribed in a square with side 3.75 cm. What is the area of the part of the square outside the circle?

C The radius of the circle is 2.53 cm. Find the area of the shaded segment.

D A square is inscribed in the quarter section of a circle. The side of the square has length 6.24 cm. Find the area of the shaded section.

See card 38 for answers

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All other answers for the numerous problems (often several problems are on a single card) appear on the reverse sides of different cards. The reverse sides also contain more challenging problems, labelled "Now Try This." Every card is discussed in detail in the teacher's guide.

The problems are attractively presented. The cards and problems are well-sequenced within separate sections on The Calculator (8 cards), Numbers (24 cards), Real Life Math (16 cards), and Extra Points (8 cards). A student record chart enables students to record problems completed and test scores. The problems are as useful today as they were in 1977.

6. How to Develop Problem Solving with a Calculator by Janet Morris.
(National Council of Teachers of Mathematics, Reston, Virginia, 1981. 44 pages, \$4.00.)

Thirty-four pages actually present lesson material, but teachers will find the five pages of introduction very helpful. Most material appears suitable for about grades 5-8.

Each page focuses on one strategy ("Find a Pattern," "Guess and Check," or "Make an Organized List or Chart") or on a strategy game. All problems are securely structured about the Polya four-step plan. Good leading questions are asked to help pupils understand the problem. In the important, often-neglected Look Back step, Morris presents questions in which pupils will "reexamine the completed solution, ... extend and generalize the solution to a class of similar situations by making up and exploring related problems, ... discuss alternative methods for solving the problem."

The pages are attractive and uncluttered. The single problem on each page appears designed to create a problem-solving atmosphere free of threat and almost

certain to make the four-step plan a natural part of the student's problem-solving activity. It is especially useful with respect to "Understanding the Problem" and "Looking Back."

Splash Time

Members in the Splash Time Swim Club is \$3.00. Each swim is \$0.25 for members and \$0.75 for nonmembers. How many times would you have to swim for it to be a better deal to be a member than a nonmember?



Understand the problem

1. If you are a member of the club and swim just one time, what does the swim cost? _____
 If you are not a member, what does one swim cost? _____ What will two swims cost a member? _____ A nonmember? _____

Decide on a plan

2. What kind of chart helps you to organize your data?

Carry out the plan

3. Complete the chart that is started for you.

Number of Swims	1	2	3	4	5	6	7	8	9	10	11	12
Member	\$3.00	\$3.25	\$3.50									
Nonmember	\$0.75	\$1.50	\$2.25			\$4.50						

4. Use the chart to compare the actual cost per swim. What does the chart tell you? How many times must you swim for it to be a better deal to be a member?

Look back

5. Make a line graph to picture the information in the chart. Use one line to show the cost for members and another to show the cost for nonmembers. What does the crossing point of the lines mean?

Calculating

6. Describe a calculator sequence that can help you quickly find the entries for each row of the chart. (Hint: Use the constant feature of the calculator.)

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SPECIAL TOPICS

7. KEYSTROKES: Calculator Activities for Young Students - Counting and Place Value by Robert E. Reys et al.
(Creative Publications, Palo Alto, California, 1980. 47 pages, \$5.95.)

With so few calculator materials available for lower grades, this booklet, designed for grades 2 and 3, is most welcome. Directions for teachers are clear and helpful. There are sections on Building Numbers, Counting On and Back, Place Value and Regrouping, Patterns, Place Value and Problem Solving, and Skip Counting. Each section is preceded by an overview to help teachers under-

stand the activities and objectives of the sections, to select activities, and to make suggestions for extensions. The grouping of similar activities aids the development of skills and concepts.

San Counting Patterns

Counting On Threes Name _____

Start at 0. Count by 3s.
0, 3, 6, 9, ...

Circle every number that you see.

1 2 3 4 5 6 7 8 9 10
11 12 13 14 15 16 17 18 19 20
21 22 23 24 25 26 27 28 29 30
31 32 33 34 35 36 37 38 39 40
41 42 43 44 45 46 47 48 49 50

① What patterns do you see? _____

② Name two other numbers that you think you will see if you continue counting. _____

Keep counting by 3s. Did you see your numbers? _____

③ Which of these numbers will you see?
Circle your guesses. Check with your _____.

100 72 161 90 113
201 93

12

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Every page contains a "listing of skills ordered by emphasis, with the first skill giving the main focus of that activity." Many pages also include suggestions for implementation. These suggestions are printed in light blue so as not to transfer to copies made for students; however, for teachers with normal vision, the suggestions are illegible.

8. Calculators in Geometry and Measurement by Charles Lund. (J. Weston

Walch, Publisher, Portland, Maine, 1981. 26 Spirit Masters, \$10.95.)

This extremely interesting set of activities is said to have been used in grades 5-12

"with some modification by the teacher," but seems more appropriate for about grades 7-9.

There are three kinds of activities. First, intuitive activities with active measurement experiences introduce or reinforce skills and concepts. For higher ability students, experiments that involve changing values of parameters in formulas enable such students to detect change patterns with length, area, and volume. Other lessons show the "relevance of mathematics" as geometry is applied in real-world situations. I found the golden pentagon activity most interesting, with students instructed to make measurements on a very clear diagram, to be used in forming ratios which students will be surprised to see are all equivalent.

NAME _____ DATE _____

AREA OF QUADRILATERALS

Compute the area of each figure below by using the given formulas, a metric ruler, and a calculator. Record your answers in the table below to the nearest tenth of a centimeter. The first problem has been done for you.

FORMULAS FOR FINDING AREA

Shape	Sample Figure	Formula
Triangle		$A = \frac{1}{2}bh$
Parallelogram		$A = bh$
Rectangle		$A = lw$
Trapezoid		$A = \frac{1}{2}h(b1 + b2)$

Figure 1:

Figure 2:

Figure 3:

Figure 4:

Figure 5:

Figure 6:

Figure 7:

Figure 8:

Figure Number	Shape	Measurements	Formula Used	Area
1	Rectangle	$b = 4.2 \text{ cm}$ $h = 2.2 \text{ cm}$	$A = b \cdot h$	9.2 cm^2
2				
3				
4				
5				
6				
7				
8				

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There are excellent discovery activities using measurements to gain understanding of the relationships. Especially suitable for grade 8 are the measurement activities to construct a brief trigonometric

table. Such activities with estimation and a strong emphasis on measurement as a basis for developing generalizations appear more likely to sustain interest and provide understanding in contrast to formal and artificial presentations in classrooms. All measurements are in centimeters and millimeters.

Teachers must choose carefully from the activities, particularly with the sections on changing values of parameters. One weakness in the masters which teachers can overcome is that some of the figures are so small that they make measurement difficult. Relative error is a severe limitation for small figures. The answer key with neatly presented tables will be appreciated by teachers.

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9. Calculators in the Classroom with Applications for Elementary and Middle School Teachers by David Moursund. (John Wiley, New York, 1981. 202 pages, \$10.45.)

Among several books which tried to present everything about calculators including why, how, and when, this book stood out. Where other books seemed sterile, dull, and unending, this one has a lively gait and attractive format. It contains instructions, suggestions, and problems sensibly distributed so that the reader's interest is maintained. The style is light, yet the content is cogent.

It is claimed to be "for both teachers and elementary and middle school students," but I think it most valuable for the teacher who wants to acquire a background of knowledge and ideas about calculators along with a very positive attitude. The purposes of the book are 1) to introduce the calculator, 2) to help the teacher apply the calculator in the classroom, and 3) to provide teachers with insights into the potential impact of calculators in the school curriculum.

There is a strong emphasis on problem solving. A chapter on problem solving

contains some interesting examples and suggestions for solving problems, but I like the continuous thread of using many more problems in the exercise sets throughout the book.

Although the mostly uncaptioned and uninspired cartoons seem all alike, they almost serve to refresh the reader at just the right time and without distraction. The short appendices include a brief review of research on calculators along with answers to exercises. This is the type of book that can be perused for a short or long time with a guaranteed reward for the reader.

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EXTRA! SOME ARTICLES

These articles provide fertile ideas, clear observations and analyses, constructive suggestions, and provocative content.

- "Calculators in the Classroom: A Proposal for Curricular Change" by Grayson Wheatley. Arithmetic Teacher, vol. 28, pages 37-39, December 1980.

This article presents a proposal for a significant reduction in the long and tedious pencil-and-paper algorithms in the present curriculum, such as long division with many-digit numbers and some work on operations with fractions. Wheatley's proposals may seem radical to some, but I would consider them rather mild in view of the reality of calculators in our lives. Wheatley concludes:

"A computationally oriented curriculum is archaic and will not prepare our students for the twenty-first century. We must shift the emphasis to applications and topics that now are crowded out by the time spent on computation. Only by excising complex computations can time be made available for applications, problem solving, and other important topics. . . . The school mathematics curriculum should be completely redesigned to emphasize mathematical reasoning and problem solving." (p. 39)

- "Calculators in Secondary School Mathematics" by Max Bell. Mathematics Teacher, vol. 71, pages 405-410, May 1978.

This title is too restrictive for the wider readership the article deserves. Bell summarizes reports of conferences, describes problems of calculator implementation, and offers suggestions. He closes with these comments:

"I believe we will succeed or fail according to how innovative and thoughtful many individual teachers are in accommodating their classrooms to the new realities of a calculator and computer age. If we fail, a substantial part of mathematics education may eventually go the way of instruction in handwriting, Greek or Latin. But if we succeed, the advent of calculators and their microelectronic cousins can help us achieve results we have long hoped for but not attained: Most, rather than a few, people leaving school a decade from now could feel a real sense of pleasure and control with respect to using mathematics in their everyday and working lives." (p. 410)

- "The Calculator Has Failed Mathematics: A Look Back at Calculators in Education" by Twila Slesnick. Computing Teacher, vol. 8, pages 52-55, No. 1, 1980-81.

This article candidly observes that calculators have failed to make measurable impact in schools. Briefly, Slesnick assesses the research rather negatively and unmasks myths about calculators. She sees little hope for significant improvement so long as "the calculator is simply being inserted into the standard textbook curriculum." She concludes:

"Even educational researchers do not investigate replacement of paper and pencil computation in elementary grades. In spite of this reluctance, calculators are rapidly becoming ubiquitous. The demands for calculator-based curricula are increasing and we are in danger of succumbing to another fruitless effort to integrate

calculators into our educational system. What is needed is not a set of calculator activities to fit into the present curriculum, but an entirely new elementary mathematics curriculum that has omitted all instruction in long algorithmic computation." (p. 17)

Slesnick observes what others have decried to no avail. I agree with the position that too-little effort and agitation for the calculator-based curriculum has failed to melt the atrophied pencil-and-paper curriculum. I disagree with the claim that research has not shown the calculator to be beneficial in mathematics learning. There are positive effects, but thus far the differences are not dramatic. Until we more boldly pursue and attain the calculator-based curriculum, we must at least take advantage of good calculator materials that are available and integrate them into the present curriculum.

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FOR ADDITIONAL READING and MATERIALS, see:

- Reference Bulletins from the Calculator Information Center
- Calculators: Readings from the Arithmetic Teacher and the Mathematics Teacher edited by Bruce Burt. National Council of Teachers of Mathematics, Reston, Virginia, 1979.

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